UPS APPLICATION PAPER

D. DeCoster, Mission Critical West Inc.
www.mcwestinc.com

15 Seconds Flywheel Reserve or 15 Minutes Battery Reserve?
The RELIABILITY difference

Conventional or traditional UPS systems routinely call out “15 minute” battery systems on guide specifications. Flywheel systems routinely call out “15 seconds” reserve time. One would think there is a one-sided advantage here, and there is, but the actual advantage may surprise many.

High Availability Design Requirements

A well designed high availability critical power system requires, by definition, that the diesel electric generation plant will start and assume load when commanded. If it does not, there is no hope to achieve minimum 99.999% (“5-9’s”) or higher availability, regardless of battery system or alternative to battery. By actual user database evaluation, this is, in fact, exactly the case for mission-critical standby genset applications. Actual diesel start reliability in one well-regarded study is proven to be on the order of 99.5% (***IEEE Gold Book (Std 493) – Appendix L, Table XII).*** Combining this start reliability with average critical site utility availability of 99.9%, and taking into account EPRI DPQ data* which confirms flywheels protect all but 2 events per year without genset back-up, we get a flywheel-supported diesel genset availability index already on the order of 99.9999+.

High standby genset start reliability is accomplished firstly by optimizing individual genset design, operation, test & maintenance parameters, routine in mission critical applications. Fuel analysis is normally required, as may be redundant starting batteries/circuits or other options. Rigorous maintenance and high-criticality testing procedures are required which are well in excess of those deployed for conventional stand-by or continuous duty applications. These measures alone increase failure-to-start reliability levels by over an order of magnitude over general duty gensets. For extreme availability applications, genset redundancy is employed. The designer may require N+1 levels of genset redundancy, or even more, depending upon availability goals. Again, the base assumption must be that the genset(s) will start and assume load, first time, every time. This is in fact what occurs in actual practice barring rare flaws in design, test or maintenance.

Reserve Time Requirements

Given the above, 15 seconds is provably more than sufficient time to comfortably transition critical loads to genset. In fact, it is also enough time to watch utility for 1-3 seconds without issuing a start command, which minimizes unnecessary diesel starts and further reduces genset dependency in the availability equation (see ***EPRI DPQ*** study). The additional reserve as provided by 5 minute or 15 minute battery-backed systems is completely superfluous. Years ago, a 15 minute allowance for “soft shutdown” of computer or other loads was a requirement. Today, it is entirely irrelevant since, by definition, shutdown whether soft or hard is intolerable. The genset(s) must start, and in fact do. Arguments that additional time allows for a “second crank” are also

without merit. This is because, in the rare case a diesel system described above does not start within the first few seconds, then like a car, it will not be starting within the next 15 minutes either.

Maintenance is Key

The great blackout of 2003 taught us many things. One of the most important was that maintenance really matters. Just as countless battery systems which appeared to be good on the surface failed, so too did many diesel generators either fail to start or failed after starting. The causes were always the same – bad fuel, dead batteries, switch or valve in the wrong position. Fortunately, these reliability issues, unlike battery reliability issues, are easy to address (see ***Diesel Reliability*** application paper)

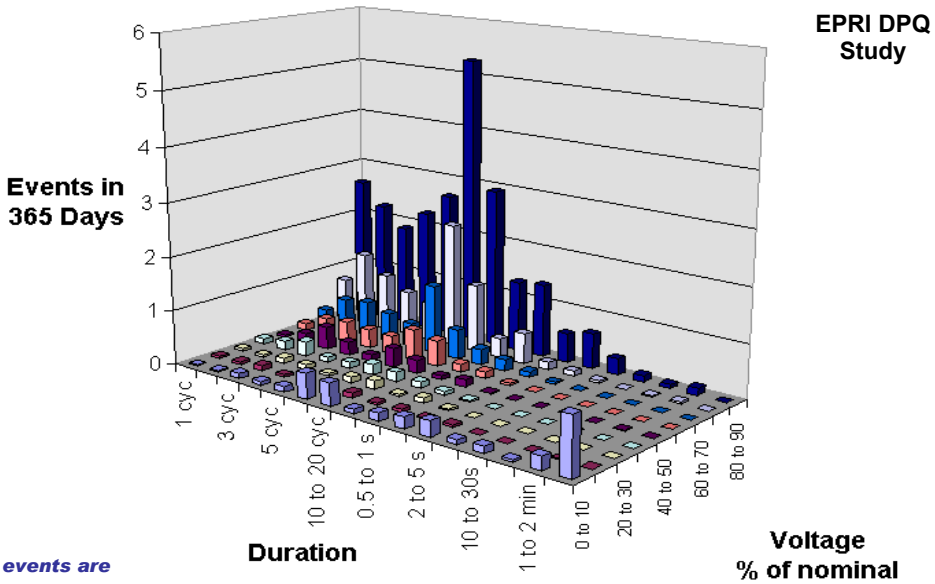
Flywheel Vs Battery Reliability

High availability UPS design calculations do not favor common VRLA battery-based systems regardless of run time, but rather flywheels. This is intrinsic in battery construction. Even if a given battery system starts off with high reliability, it falls off rapidly with time. This is particularly true with VRLA batteries which show a documented 20% failure rate in just the 2 to 3 year age range (see ***VRLA Reliability*** application paper). If failed cells are not immediately replaced, even with redundant strings, the probability that a complete load loss from open circuit failure is provably far greater than the probability of load loss from failure of diesel(s) to start in a flywheel-backed system.

Summary

When designing for high availability, such as a 99.9999% availability goal, reserve time is meaningless. Rather, the relative reliabilities & availabilities of DC reserve power sources, along with those of the UPS & genset itself, will determine true system availability.

Figure 1: RMS Voltage Variation Sag and Interruption Rate



Note: 98% of events are disturbances well under 5 secs in duration.